TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 300

PRESSURE DISTRIBUTION ON FUSELAGE OF AIRPLANE MODEL.

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PRESSURE DISTRIBUTION ON FUSELAGE OF AIRPLANE MODEL.*

The method of determining the pressure distribution on the fuse-
lage is described, with special attention to how it is affected by
the presence of the wings.

1. Introduction.- The published results of experiments with
fuselage models give only data on forces and moments, but not on
pressure distribution. This was, in fact, determined for several
streamlined rotational bodies, but, since many airplane fuselages
differ greatly from these, it was desirable to determine the pressure
distribution in a special case. This was all the more desirable,
because the opinion is commonly held by airplane constructors that
the negative pressures on the curved portions of a fuselage are the
same as on a wing.

2. Description of model.- There was employed for this inves-
tigation the airplane model No. 5, consisting of an old form of the
Fokker F 3 airplane with a thick wing attached to the top of the fus-
elage (Fig. 1). This fuselage was chosen, because its under surface
has a smooth curved contour. The wing was not a model of the one
on the F 3 airplane, but was perfectly suited for the contemplated

tests. The scale of the fuselage model was about 1:30, while the proportions of the fuselage and wing were approximately the same as on the F 3 airplane. Fig. 1 gives an assembly drawing of the model, while Figs. 2 and 3 give respectively the dimensions of the fuselage and of two cross-sections of the wing. Both fuselage and wing were made of mahogany and carefully polished. The wing could be removed from the fuselage.

For determining the pressure distribution, small semi-tubes of copper were set into the top and bottom and one side of the fuse-lage, as shown in Figs 1 and 4. These consisted, as shown in Fig. 4, of half of a round tube on which a flat covering plate was soldered. The tubes were attached to the surface by means of a flange on the covering plate set flush with the surface. At intervals of 10 mm (0.4 in.), 5 mm (0.2 in.) holes were bored in this plate, care being taken to avoid rough edges which might affect the results. The pressure tubes set in the bottom and side of the fuselage extended from the nose to a point 32 mm (1.26 in.) from the rear end and in the top from the trailing edge of the wing to the same point. Subsequently the wooden rear portion was replaced by copper, in order to be able to determine the pressure distribution on the rearmost portion of the fuselage also. This was accomplished by means of holes, connecting with the tubes already introduced into the model, which were likewise connected by holes with the upper surface. Each tube was connected with a nozzle which opened on the opposite surface of the fuselage. When the pressure was measured on another surface,

the nozzle was removed and the hole was smoothly closed with paraffin.

In the experiment, the model was hung in the usual manner on the horizontal arm of an Eiffel balance by means of two streamlined rods attached to the fuselage. In determining the pressure on the top surface, these rods were attached to the bottom and in the other case to the top. So far as was necessary for attaching the supporting rods, the pressure-measuring tubes were removed and replaced by wooden plugs.

3. Method.- Before measuring the pressure distribution on one of the surfaces, the pressure tube in this surface was connected with one side of a liquid micromanometer (Fig. 5). The other side of this instrument, in order to maintain a constant counter-pressure, was connected with a tube which opened vertically on the wall of the tunnel. The three-way cock in the pipe between the model and the manometer, the third branch of which was connected with the tube in the tunnel wall, served for control tests, to be further described.

Before measuring the pressure at one hole, all the other holes in the same pressure tube were closed with a fused mixture of tallow and vaseline.

In performing the experiments, special attention was given two points:

1. That the closed openings in a tube did not leak;

2. That, in opening a hole, there was left none of the stopping substance, nor any ridges nor other unevenness in the vicinity.

To discover leaks, tests were made at regular intervals, e.g., after testing five holes, by closing the last hole without opening the following one. If the wind was then turned on, the manometer jumped strongly, because the pressure remained constant in the model, while the pressure in the air stream decreased. In order to anticipate this, the three-way cock was turned, during the adjustment, to the second position, thus equalizing the pressure on both sides of the manometer and in the model with that in the tube in the tunnel wall. After attaining the desired wind velocity, the cock was turned back to position 1. If there was no leak in the model, the reading of the manometer then remained at zero.

Serious disturbances were at first produced by the cause mentioned under point 2. A small wire was used for removing the stopping substance from the holes. Better results were subsequently obtained by employing a straight metal rod, whose diameter was but slightly smaller than the diameter of the hole. With this rod the stopping material was pressed in all together. By this method good results were obtained, the successive measurements differing but slightly. Aside from the effect of the sharp edges, to be discussed later, the maximum differences amounted to less than 2% of the dynamic pressure. After the completion of the measurements on one of the surfaces, several of the points were retested for corroberation. In closing each hole, care was taken to make the stopping material flush with the covering plate, since otherwise turbulence would be produced, which might affect the pressure at

the next hole.

In this manner, the pressure difference between the model and the opening in the tunnel wall was determined. Since the purpose, however, was to determine the difference between the pressure on the model and the static pressure in the undisturbed air stream at the same point, a small correction was made for this purpose. This correction was determined, after removing the model, by measuring the static pressure opposite the opening in the tunnel wall by means of a Pitot tube of the N.P.L. standard type.

The measured pressures p were converted into percentages of the dynamic pressure $p_o = \frac{1}{2} \rho V^2$, in which p_o = dynamic pressure in kg/m^2, ρ = a similar mass of air in $kg-sec^2/m^4$, V = velocity of the undisturbed current in m/sec.

4. Results.- The position of the model with reference to the direction of the wind was determined by the angle of attack and the angle of yaw. The angle of attack α is the angle made by the chord of the middle section of the wing (= upper surface of fuselage) with the direction of the wind. The angle of yaw β is the angle between the plane of symmetry of the model and the direction of the wind.

The pressure distribution was measured:

a) On the bottom at angles of attack of $-5°$, $0°$, $5°$, $10°$ and zero angle of yaw;

b) On the side at zero angle of attack and $-10°$, $-5°$, $0°$, $5°$, $10°$ angle of yaw;

c) On the top at angles of attack of -5°, 0°, 5°, 10° and zero angle of yaw.

All these experiments were performed both with and without the wing. Moreover, the effect of the sharp edge on the front end of the model was investigated and the pressure distribution was also determined after the fuselage had been provided with a round nose, as shown by dotted line in Fig. 1.

The experiments were performed at a wind velocity of 28 m (92 ft.) per second. The results are given in Figs. 6-9. The presentation of the numerical values in table form was omitted because the curves satisfactorily represent the course of the pressure and the numerical values for each individual point are less important. Herein every point gives the mean of several (usually 3) observations during an experiment. For different tests with the same location of the model, the points are represented by different symbols, in so far as they do not coincide. Each figure is accompanied by a sketch of the model, in order to show the location of the hole on the fuselage, while arrows indicate the directions in which the angles α and β are measured.

Pressure distribution on the bottom (Fig. 6).- Except in the foremost points, where the effect of the sharp transition between the front and bottom surface at different angles of attack caused quite different pressure values, the curves have the same character. Great negative pressures (up to 33% of the dynamic pressure) occurred only on the foremost portion. The maximum negative pressure

decreased as the angle of attack increased. The negative pressure gradually decreased toward the rear end and finally changed to a small positive pressure amounting, at the last hole, to 6-9% of the dynamic pressure. The wing increased the pressure at all angles of attack, due to the air circulation which always diminished the velocity under the wing, thus increasing the pressure. Hence the pressure difference for the model, with or without the wing, increased with increasing angle of attack and the consequent increase in circulation.

Pressure distribution on the side (Figs. 7 and 8).- For a wingless fuselage, the curves exhibit the same character as for the under surface. Even here the presence of a wing generally increased the pressure, but the effect was more localized. The sharp nose caused an irregular flow, which is indicated by the irregular course of the curves for the foremost portion (see $\alpha = 0$). When this sharp edge was eliminated by adding a round nose, these irregularities disappeared (Fig. 8). The round nose somewhat changed the pressure distribution on the front portion but did not affect the remaining portion.

Pressure distribution on the top (Fig. 9).- For the wingless model, the pressure on the front portion was nearly constant and on the rear portion it changed to a positive pressure of the same magnitude as on the bottom and side. The wing caused an entirely different flow on the adjacent and rear portions. At small angles of

attack there was here a positive pressure, but at large angles of attack there was a strong negative pressure, due to the eddies formed in the angle between the wing and fuselage.

Comparison with the pressure distribution on other bodies.- The pressure distribution on the fuselage was similar to that on streamlined rotational bodies and on the top of wings at angles of attack below the critical angle.* Only the effect of the sharp nose caused deviations. The pressures on the streamlined bodies were of the same order of magnitude. The negative pressures on the wings were much greater, however, the maximum being about 300% of the dynamic pressure, while on the fuselage it did not exceed 33%.

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* Norton and Bacon: "Pressure Distribution on Thick Airfoils, Model Tests." Report No. 150 of the N.A.C.A.

Table I.

Airplane Model No. 5.

Pressure on the bottom of the fuselage
in % of the dynamic pressure

$\beta = 0^{\circ}$ $V = 28$ m/sec.(about).

Hole	$\alpha = +10^{\circ}$ With wing			Without wing			$\alpha = +5^{\circ}$ With wing			Without wing		
1	+27.9	+28.1	–	+22.6	+22.3	–	+26.3	+24.6	–	+ 6.5	+ 7.2	–
2	+25.8	+26.5	–	+ 7.0	+ 6.8	–	+24.4	+24.6	–	− 0.5	− 4.9	–
3	+26.3	+28.6	–	− 1.9	− 1.6	–	+26.5	0	–	− 6.5	−13.0	–
4	+ 6.3	+ 7.0	–	− 8.4	− 8.8	–	− 6.3	− 5.4	–	−13.0	−17.7	–
5	+ 2.1	+ 2.1	–	−14.7	−14.9	–	− 9.1	− 8.8	–	−18.1	−23.0	–
6	− 4.2	− 3.7	–	−17.7	−17.7	–	−12.6	−12.8	–	−24.6	−24.2	–
7	− 4.7	− 5.1	–	−18.8	−19.3	–	−13.7	−14.4	–	−26.5	−24.9	–
8	− 5.8	− 4.7	–	−18.1	−18.6	–	−12.6	−11.6	–	−22.8	−25.3	–
9	− 4.2	− 4.2	–	−16.5	−15.4	–	−10.2	− 9.5	–	−19.3	−19.5	–
10	− 2.6	− 2.3	–	−14.4	−13.9	–	− 7.0	− 7.2	–	−17.7	−17.9	–
11	− 1.6	− 1.9	–	−15.1	−12.3	–	− 5.6	− 5.1	–	−15.3	−15.3	–
12	− 2.8	− 2.3	–	−12.8	−13.0	–	− 4.7	− 5.1	–	−15.3	−15.1	–
13	− 3.7	− 3.7	–	−12.8	−14.4	–	− 6.3	− 6.0	–	−14.9	−14.9	–
14	− 4.4	− 4.9	–	−14.4	−14.2	–	− 6.3	− 6.0	–	−15.8	−15.7	–
15	− 5.1	− 5.4	–	−13.7	−13.5	–	− 6.8	− 6.0	–	−14.9	−14.6	–
16	− 5.6	− 5.4	–	−14.0	−13.5	–	− 6.0	− 6.0	–	−14.4	−14.6	–
17	− 5.6	− 5.8	–	−13.3	−14.4	–	− 6.8	− 6.0	–	−14.0	−13.7	–
18	− 5.4	− 5.8	–	−13.0	−13.5	–	− 5.4	− 5.6	–	−11.9	−12.8	–
19	− 6.0	− 6.0	–	−13.7	−13.5	–	− 5.6	− 5.6	–	−13.7	−13.0	–
20	− 5.4	− 5.4	–	−12.8	−12.6	–	− 4.9	− 4.9	–	−11.6	−12.5	–
21	− 6.0	− 6.0	–	−12.6	−12.6	–	− 4.7	− 4.9	–	−11.4	−11.4	–
22	− 5.6	− 5.8	–	−11.9	−12.1	–	− 4.2	− 4.9	–	−11.2	−10.7	–
23	− 4.2	− 4.2	–	−11.4	−11.2	–	− 2.8	− 3.0	–	− 9.5	− 9.3	–
24	− 3.5	− 3.7	–	− 9.5	− 9.8	–	− 1.9	− 2.3	–	− 8.2	− 7.9	–
25	− 2.1	− 2.3	−2.0	− 7.9	− 8.4	−6.8	− 0.5	− 1.0	−0.7	− 6.8	− 6.8	−5.0
26	− 1.2	− 1.2	−0.7	− 6.0	− 6.3	−5.2	0	0	+1.1	− 4.4	− 4.7	−3.0
27	+ 1.0	+ 1.0	+1.6	− 4.2	− 4.0	−2.4	+ 2.3	+ 2.1	+3.1	− 2.3	− 2.3	−0.9
28	–	–	+3.6	–	–	+0.3	–	–	+5.2	–	–	+2.0
29	–	–	+6.1	–	–	+2.9	–	–	+6.4	–	–	+3.9
30	–	–	+8.9	–	–	+6.9	–	–	+8.0	–	–	+6.9

Table I (Cont.)

Airplane Model No. 5.

Pressure on the bottom of the fuselage
in % of the dynamic pressure.

$$\beta = 0^{\circ} \qquad V = 28 \text{ m/sec.(about)}$$

Hole	α = 0° With wing			α = 0° Without wing			α = -5° With wing			α = -5° Without wing		
1	-13.7	-13.0	–	-22.6	-22.3	–	-59.3	-60.3	–	-57.5	-58.2	–
2	-13.3	- 8.6	–	-13.3	-13.7	–	-22.1	-21.9	–	-20.7	-20.2	–
3	-14.7	-13.5	–	-22.8	-19.5	–	-27.0	-27.0	–	-26.0	-26.5	–
4	-19.8	-17.7	–	-24.9	-24.7	–	-30.9	-31.2	–	-29.8	-29.5	–
5	-21.2	-19.8	–	-29.5	-27.9	–	-33.3	-31.9	–	-31.8	-31.8	–
6	-22.8	-21.8	–	-28.4	-27.9	–	-32.1	-32.1	–	-31.2	-31.4	–
7	-22.1	-21.4	–	-28.4	-27.4	–	-30.5	-30.2	–	-29.3	-31.4	–
8	-18.6	-18.1	–	-25.1	-24.9	–	-25.6	-25.1	–	-25.3	-25.3	–
9	-15.4	-14.9	–	-20.7	-20.9	–	-20.9	-20.9	–	-20.7	-20.9	–
10	-11.4	-10.7	–	-18.8	-18.4	–	-15.6	-16.0	–	-17.7	-18.7	–
11	- 8.8	- 8.4	–	-17.0	-15.4	–	-12.3	-12.1	–	-14.9	-15.1	–
12	- 7.7	- 7.4	–	-15.4	-14.9	–	-10.5	-10.7	–	-13.9	-13.9	–
13	- 7.7	- 7.0	–	-15.1	-13.9	–	- 9.3	- 9.3	–	-13.5	-13.5	–
14	- 7.0	- 6.8	–	-14.4	-15.4	–	- 8.4	- 8.4	–	-12.8	-13.2	–
15	- 6.5	- 6.5	–	-13.9	-13.5	–	- 7.4	- 7.4	–	-11.9	-11.6	–
16	- 6.0	- 5.6	–	-13.3	-13.0	–	- 6.5	- 6.3	–	-10.9	-11.2	–
17	- 5.4	- 5.1	–	-12.1	-11.9	–	- 5.6	- 5.6	–	- 9.8	- 9.3	–
18	- 4.7	- 4.4	–	-11.6	-11.1	–	- 4.7	- 4.7	–	- 8.8	- 8.6	–
19	- 4.4	- 4.2	–	-10.7	-10.9	–	- 3.7	- 4.2	–	- 8.4	- 7.9	–
20	- 3.5	- 3.3	–	- 9.8	- 9.8	–	- 3.5	- 3.5	–	- 7.0	- 7.2	–
21	- 3.3	- 2.8	–	- 8.8	- 8.6	–	- 3.0	- 2.8	–	- 6.0	- 5.8	–
22	- 2.8	- 2.6	–	- 8.4	- 7.7	–	- 2.8	- 2.6	–	- 5.4	- 5.4	–
23	- 1.4	- 1.4	–	- 6.5	- 6.5	–	- 0.5	- 1.0	–	- 4.2	- 4.2	–
24	- 0.5	- 0.5	–	- 5.1	- 4.7	–	+ 0.5	0	–	- 3.3	- 3.0	–
25	+ 0.5	+ 0.5	+0.6	- 4.0	- 4.0	-2.2	+ 1.2	+ 1.2	+1.4	- 2.1	- 2.1	-0.6
26	+ 1.0	+ 1.4	+2.0	- 2.3	- 2.1	-0.7	+ 1.9	+ 2.3	+2.3	- 0.5	- 0.5	+0.6
27	+ 2.3	+ 2.6	+3.3	- 0.5	- 0.5	+1.1	- 3.7	+ 3.5	+3.7	+ 0.5	+ 0.5	+2.0
28	–	–	+5.2	–	–	+2.8	–	–	+5.4	–	–	+3.5
29	–	–	+6.3	–	–	+4.2	–	–	+6.4	–	–	+4.2
30	–	–	+ 7.9	–	–	+5.9	–	–	+6.9	–	–	+5.8

Table II.

Airplane Model No. 5 with flat nose.

Pressure on side of fuselage in % of dynamic pressure.

$$\alpha = 0^{\circ} \qquad V = 28 \text{ m/sec. (about)}$$

Hole	$\beta = +10^{\circ}$					
	With wing			Without wing		
1	+39.5	+40.0	–	+27.0	+27.9	–
2	+23.7	+23.5	–	+ 5.6	+ 5.4	--
3	+12.3	+12.3	–	– 3.7	– 7.7	
4	– 3.7	– 3.0	–	–13.0	–18.8	–
5	–15.1	–14.9	–	–24.4	–24.4	–
6	–16.7	–16.7	–	–22.1	–21.8	–
7	–13.5	–13.3	–	–17.9	–17.7	–
8	–10.0	– 9.8	–	–14.4	–14.0	–
9	– 7.2	– 7.2	–	–12.3	–11.9	–
10	– 5.6	– 5.8	–	–12.3	–12.3	–
11	– 3.3	– 3.3	–	–12.1	–11.6	–
12	0	0	–	–11.2	–11.2	–
13	+ 2.1	+ 2.3	–	–11.6	10.9	–
14	+ 2.6	+ 2.6	–	–11.9	–11.2	–
15	– 0.5	– 0.5	–	–12.1	–12.1	–
16	– 4.2	– 4.0	–	–13.2	–13.0	–
17	– 6.0	– 6.0	–	–12.6	–12.3	–
18	– 7.0	– 7.0	–	–11.9	–11.6	–
19	– 7.2	– 7.4	–	–10.5	–10.2	–
20	– 7.7	– 7.9	–	– 9.8	– 9.8	–
21	– 7.2	– 7.4	–	– 9.8	– 9.3	–
22	– 8.4	– 8.6	–	– 9.8	–10.0	–
23	– 8.4	– 7.9	–	– 9.8	–10.0	–
24	– 8.8	– 8.6	–	– 9.5	–10.0	–
25	– 7.7	– 7.7	–6.7	– 8.1	– 8.8	–8.4
26	– 7.2	– 7.2	–6.5	– 7.9	– 8.2	–7.5
27	– 5.6	– 6.0	–5.1	– 7.0	– 6.8	–6.5
28	–	–	–4.0	–	–	–4.9
29	–	–	–0.9	–	–	–2.1
30	–	–	+2.3	–	–	+1.3

Table II (Cont.)

Airplane Model No. 5 with flat nose.

Pressure on side of fuselage in % of dynamic pressure.

$a = 0°$ $V = 28$ m/sec. (about)

Hole	β = +5°			β = 0°			
	With wing			With wing			
1	+29.1	+29.1	—	− 5.6	+ 3.7	+13.2	—
2	+11.2	+10.7	—	+ 3.3	+ 3.0	—	—
3	+ 1.0	+ 0.5	—	− 1.9	− 1.9	− 9.8	—
4	−14.7	−14.4	—	−12.5	−12.5	—	—
5	−24.9	−24.9	—	− 6.0	− 5.8	—	—
6	−24.6	−24.6	—	−20.9	−20.9	−30.2	—
7	−19.3	−19.5	—	−16.0	−15.8	—	—
8	−14.2	−14.4	—	−12.3	−12.1	—	—
9	−10.2	−10.2	—	− 9.3	− 9.3	−12.1	—
10	− 8.4	− 8.4	—	− 8.4	− 8.4	—	—
11	− 4.7	− 5.1	—	− 6.8	− 6.5	—	—
12	− 1.0	− 1.4	—	− 3.7	− 4.0	− 2.8	—
13	+ 1.2	+ 1.0	—	− 2.3	− 2.1	—	—
14	+ 1.0	+ 1.0	—	− 1.9	− 1.6	—	—
15	− 2.3	− 2.3	—	− 2.8	− 2.8	− 2.8	—
16	− 5.1	− 5.1	—	− 4.9	− 5.1	—	—
17	− 6.5	− 6.5	—	− 6.0	− 6.0	—	—
18	− 7.0	− 6.8	—	− 7.0	− 6.8	− 6.8	—
19	− 7.4	− 7.2	—	− 6.5	− 6.8	—	—
20	− 7.7	− 7.4	—	− 7.0	− 7.2	—	—
21	− 7.4	− 7.4	—	− 7.0	− 7.0	− 7.0	—
22	− 8.2	− 8.4	—	− 7.4	− 7.4	—	—
23	− 8.2	− 8.4	—	− 7.4	− 7.4	—	—
24	− 7.9	− 8.2	—	− 6.5	− 6.8	− 7.9	—
25	− 7.0	− 7.4	−6.0	− 5.6	− 5.6	—	−4.2
26	− 7.2	− 7.4	−5.4	− 4.7	− 4.9	—	−3.1
27	− 6.5	− 7.0	−4.7	− 3.7	− 3.7	− 4.2	−2.0
28	—	—	−3.6	—	—	—	−1.2
29	—	—	−1.2	—	—	—	+1.5
30	—	—	+1.9	—	—	—	+4.8

Table II (Cont.)

Airplane Model No. 5 with flat nose.

Pressure on side of fuselage in % of dynamic pressure.

$\alpha = 0°$ $V = 28$ m/sec. (about)

Hole	β = 0° Without wing			β = -5° With wing			β = -10° With wing			β = -10° Without wing		
1	+ 2.6	+ 4.2	—	-33.0	-33.7		-57.4	-58.2		-73.3	-71.0	—
2	-20.0	-18.1	—	-11.2	-11.2	—	-24.6	-25.1	—	-30.9	-31.4	—
3	-28.8	-28.6	—	-20.9	-20.0	—	-30.2	-30.2	—	-38.6	-38.3	—
4	-37.0	-36.5	—	-34.4	-33.0	—	-43.9	-48.8	—	-41.8	-41.8	—
5	-38.6	-38.3	—	-41.8	-40.4	—	-50.3	-50.7	—	-39.4	-38.3	—
6	-33.0	-32.6	—	-36.1	-35.1	—	-42.1	-42.6	—	-30.9	-31.1	—
7	-25.1	-24.9	—	-27.2	-26.7	—	-31.9	-31.9	—	-23.7	-23.5	—
8	-19.5	-19.3	—	-20.5	-20.2	—	-24.4	-24.4	—	-18.6	-18.4	—
9	-16.5	-16.7	—	-15.1	-13.3	—	-18.1	-18.1	—	-16.3	-15.6	—
10	-15.8	-16.0	—	-11.6	-11.6	—	-14.2	-14.4	—	-15.4	-15.1	—
11	-14.9	-15.4	—	- 8.2	- 7.9	—	-10.5	-10.7	—	-14.4	-14.4	—
12	-14.4	-14.2	—	- 4.9	- 4.7	—	- 6.8	- 7.0	—	-14.0	-14.0	—
13	-14.0	-13.7	—	- 2.3	- 2.3	—	- 4.7	- 4.7	—	-14.0	-14.0	—
14	-14.2	-13.7	—	- 2.1	- 1.9	—	- 3.5	- 3.7	—	-14.4	-14.0	—
15	-14.4	-14.2	—	- 3.3	- 3.5	—	- 4.7	- 4.7	—	-16.5	-14.4	—
16	-14.4	-14.2	—	- 5.4	- 5.4	—	- 6.0	- 6.3	—	-15.1	-14.6	—
17	-12.8	-12.8	—	- 6.0	- 5.8	—	- 6.5	- 6.5	—	-14.4	-13.7	—
18	-11.6	-11.4	—	- 6.3	- 6.3	—	- 6.8	- 7.0	—	-14.2	-13.2	—
19	-10.5	-10.2	—	- 6.5	- 6.5	—	- 7.2	- 7.0	—	-13.2	-12.8	—
20	-10.0	-10.0	—	- 7.0	- 7.0	—	- 7.7	- 7.7	—	-13.0	-13.0	—
21	- 9.8	- 9.3	—	- 7.2	- 7.4	—	- 8.4	- 8.2	—	-13.2	-13.5	—
22	- 9.8	- 9.5	—	- 8.4	- 8.2	—	- 9.5	- 9.8	—	-14.4	-14.4	—
23	- 9.3	- 9.3	—	- 8.4	- 9.3	—	-10.2	-10.2	—	-14.4	-14.2	—
24	- 8.4	- 8.2	—	- 7.0	- 7.4	—	- 9.5	- 9.8	—	-12.8	-12.6	—
25	- 6.8	- 6.5	-6.4	- 5.6	- 5.8	-4.3	- 8.2	- 7.9	-5.9	-10.5	-10.7	-9.3
26	- 5.6	- 5.4	-5.3	- 4.9	- 4.9	-3.7	- 7.2	- 7.0	-4.5	- 8.8	- 9.3	-7.5
27	- 3.7	- 4.0	-3.7	- 3.7	- 3.7	-1.9	- 5.6	5.6	-3.9	- 6.8	- 7.0	-5.3
28	—	—	-2.1	—	—	-0.5	—	—	-2.9	—	—	-3.5
29	—	—	+0.6	—	—	+1.9	—	—	-0.1	—	—	-0.0
30	—	—	+4.1	—	—	+5.3	—	—	+3.9	—	—	+3.2

Table III.

Airplane Model No. 5 with wing and round nose.

Pressure on side of fuselage in % of dynamic pressure.

$\alpha = 0^O$ $V = 28$ m/sec. (about)

Hole	$\beta = +10^O$		$\beta = 0^O$		$\beta = -10^O$	
1	+38.6	+38.4	+12.8	+11.9	-16.5	-16.3
2	+23.5	+23.2	- 0.5	- 0.5	-27.2	-27.0
3	+11.6	+12.1	- 9.8	- 9.8	-37.2	-37.0
4	- 3.7	- 4.0	-23.7	-23.9	-52.2	-52.2
5	-15.6	-15.3	-32.8	-32.3	-56.3	-56.1
6	-16.7	-16.5	-29.8	-29.5	-48.3	-48.3
7	-13.5.	-13.2	-23.0	-23.2	-36.7	-36.7
8	- 9.8	- 9.8	-18.6	-18.6	-27.2	-26.7
9	- 7.0	- 7.2	-14.0	-13.0	-20.0	-20.0
10	- 5.6	- 5.8	-10.0	-10.2	-15.6	-15.3
11	- 3.0	- 3.3	- 6.8	- 6.8	-11.4	-10.9
12	0	0	- 2.6	- 2.8	- 7.7	- 7.4
13	+ 2.8	+ 2.3	- 0.5	- 1.0	- 5.4	- 5.4
14	+ 2.8	+ 2.3	0	- 0.5	- 4.4	- 4.7
15	- 0.5	- 0.5	- 2.3	- 2.6	- 5.4	- 5.1
16	- 4.2	- 4.7	- 5.1	- 5.4	- 6.5	- 6.5
17	- 5.8	- 6.0	- 6.0	- 6.5	- 7.0	- 7.0
18	- 6.8	- 7.2	- 6.8	- 7.0	- 7.0	- 7.2
19	- 7.7	- 7.4	- 7.0	- 7.2	- 7.7	- 7.7
20	- 7.4	- 7.9	- 7.2	- 7.0	- 8.4	- 8.2
21	- 7.0	- 7.4	- 7.4	- 7.7	- 9.3	- 8.8
22	- 8.4	- 8.6	- 8.4	- 8.4	-10.9	-10.9
23	- 8.8	- 8.8	- 8.4	- 8.6	-12.1	-11.4
24	- 8.4	- 9.1	- 7.9	- 8.2	-11.4	-11.2
25	- 7.4	- 7.7	- 6.8	- 6.8	-10.0	-10.0
26	- 7.0	- 7.0	- 6.0	- 6.0	- 9.1	- 8.8
27	- 5.6	- 5.8	- 4.9	- 4.7	- 7.4	- 7.4

Table IV.

Airplane Model No. 5.

Pressure on top of fuselage in % of dynamic pressure.

$\beta = 0^{\circ}$ $V = 28$ m/sec. (about)

Hole	$\alpha = +10^{\circ}$		$\alpha = +5^{\circ}$		$\alpha = 0^{\circ}$		$\alpha = -5^{\circ}$	
	With wing	Without wing	With wing	Without wing	With wing	Without wing	With wing	Without wing
1	-29.1	-5.8	-16.5	-5.8	-3.5	-6.5	+10.0	-6.3
2	-26.0	-6.0	-11.2	-6.0	+4.0	-7.4	+18.6	-7.0
3	-16.7	-6.5	- 4.4	-6.5	+6.8	-7.7	+14.6	-8.2
4	- 9.1	-6.3	0	-6.5	+4.2	-8.8	+ 7.0	-8.2
5	- 4.4	-6.0	+ 0.5	-6.8	+1.4	-7.9	+ 2.3	-8.8
6	- 2.3	-5.6	- 0.5	-6.5	-1.6	-7.9	0	-7.9
7	- 0.5	-5.1	- 1.0	-6.0	-3.0	-7.2	- 2.6	-7.9
8	0	-5.6	- 2.6	-6.0	-3.5	-7.7	- 4.2	-8.4
9	- 0.5	-5.4	- 3.5	-5.8	-5.1	-7.7	- 5.6	-8.4
10	0	-5.1	- 3.0	-5.1	-5.4	-7.0	- 5.4	-7.9
11	- 0.5	-4.4	- 3.5	-4.9	-5.1	-6.0	- 5.6	-7.7
12	- 1.0	-4.2	- 2.8	-4.2	-5.4	-5.4	- 5.4	-7.0
13	- 1.6	-3.3	- 2.6	-4.0	-4.7	-5.4	- 5.1	-6.3
14	- 0.5	-2.6	- 2.3	-2.8	-3.7	-4.0	- 4.2	-5.6
15	0	-1.2	- 1.0	-1.9	-2.1	-2.8	- 1.9	-4.0
16	+ 1.0	0	+ 0.5	-0.5	-0.5	-1.9	- 0.5	-2.3
17	+ 2.1	+1.2	+ 2.1	+1.0	+1.4	0	+ 1.0	0
18	+ 5.1	+5.1	+ 4.7	+5.4	+5.1	+4.0	+ 4.9	+3.7

|←63→|

A   A

All dimensions
in mm.

600

|←98→|

B   B
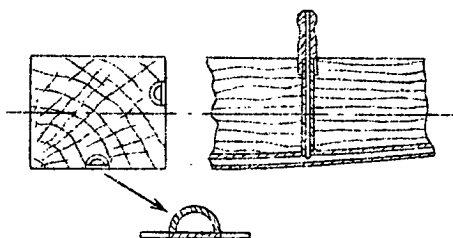
303.5
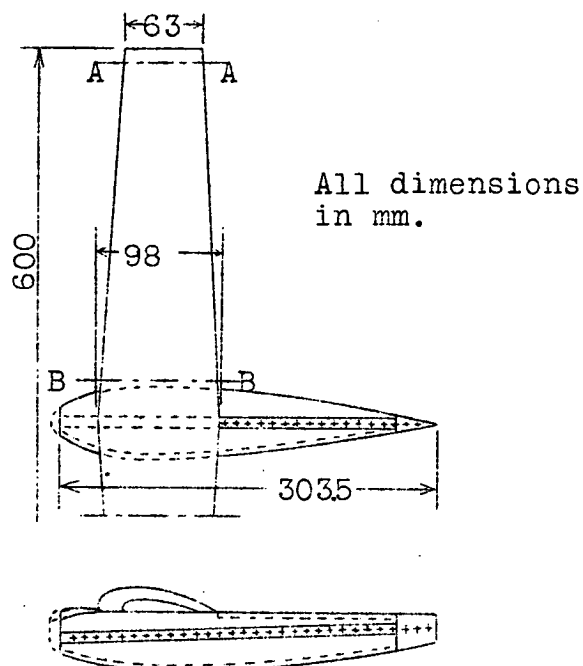
Fig.1 Airplane model No.5

Fig.4 Construction of pressure tubes.
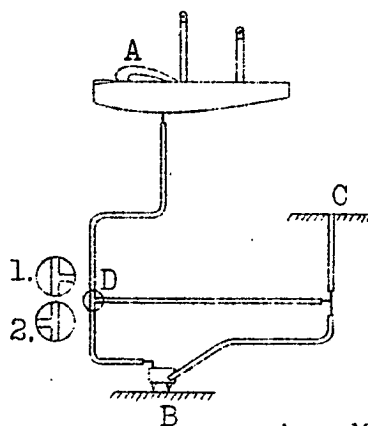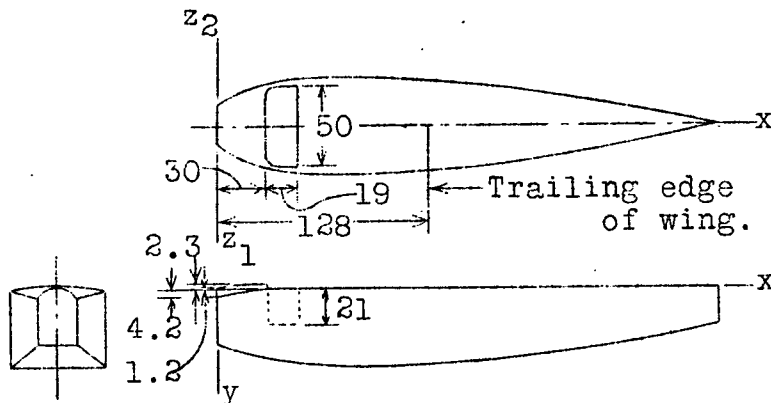
A

C

1.

D

2.

B

Fig.5 Pressure-
measuring device.

A = Model
B = Micromanometer
C = Tube in tunnel wall
D = Three-way cock

Fuselage of the model.

Fuselage dimensions in millimeters.

x	y	z_1	z_2	x	y	z_1	z_2
0	33.5	10.3	12.8	160	43.6	24.0	24.1
10	36.9	17.1	17.7	170	43.0	22.9	22.9
20	39.6	22.1	21.7	180	42.1	21.7	21.7
30	41.8	25.5	24.7	190	41.2	20.4	20.3
40	43.7	27.5	26.7	200	40.1	19.0	18.8
50	44.9	28.3	27.8	210	38.8	17.6	17.4
60	45.9	28.6	28.4	220	37.8	16.0	15.8
70	46.5	28.8	28.5	230	36.1	14.4	14.2
80	46.7	28.8	28.5	240	34.6	12.7	12.7
90	46.7	28.6	28.4	250	32.9	10.9	10.8
100	46.4	28.5	28.1	260	31.2	9.0	9.0
110	46.3	28.1	27.7	270	29.3	7.0	7.0
120	45.9	27.6	27.1	280	27.6	5.2	5.2
130	45.5	26.8	26.6	290	25.7	3.2	3.2
140	44.9	25.9	25.8	300	23.7	1.2	1.2
150	44.3	25.1	25.1	303.5	22.7	0.0	0.0

Fig. 2
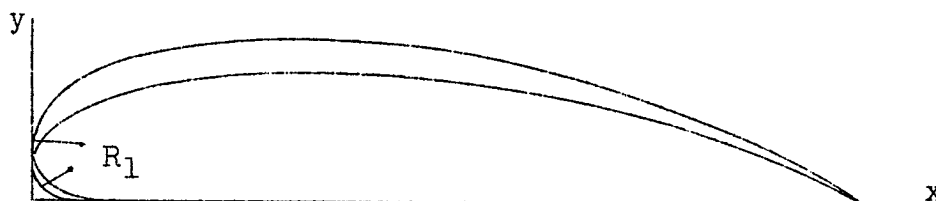
Sections AA and BB of the model.

Section AA.

Measurements in %.

x	y_1	y_2	x	y_1	y_2
0.00	4.50	4.50	50.00	0.00	14.50
1.25	1.35	7.40	60.00	0.00	13.20
2.50	0.50	8.60	70.00	0.00	11.20
5.00	0.00	10.25	80.00	0.00	8.40
7.50	0.00	11.40	90.00	0.00	4.75
10.00	0.00	12.35	95.00	0.00	2.55
15.00	0.00	13.70	100.00	0.00	0.00
20.00	0.00	14.75	R_1	4.30	--
30.00	0.00	15.40	R_2	0.00	--
40.00	0.00	15.15	--	--	--

Section BB.

Measurements in %.

x	y_1	y_2	x	y_1	y_2
0.00	6.35	6.35	50.00	0.00	18.30
1.25	2.75	10.50	60.00	0.00	16.30
2.50	1.30	12.00	70.00	0.00	13.50
5.00	0.20	14.00	80.00	0.00	10.00
7.50	0.05	15.45	90.00	0.00	5.80
10.00	0.00	16.50	95.00	0.00	3.30
15.00	0.00	17.85	100.00	0.00	0.00
20.00	0.00	18.70	R_1	7.00	--
30.00	0.00	19.35	R_2	0.00	--
40.00	0.00	19.20	--	--	--

Fig. 3.

O + × Without wing.
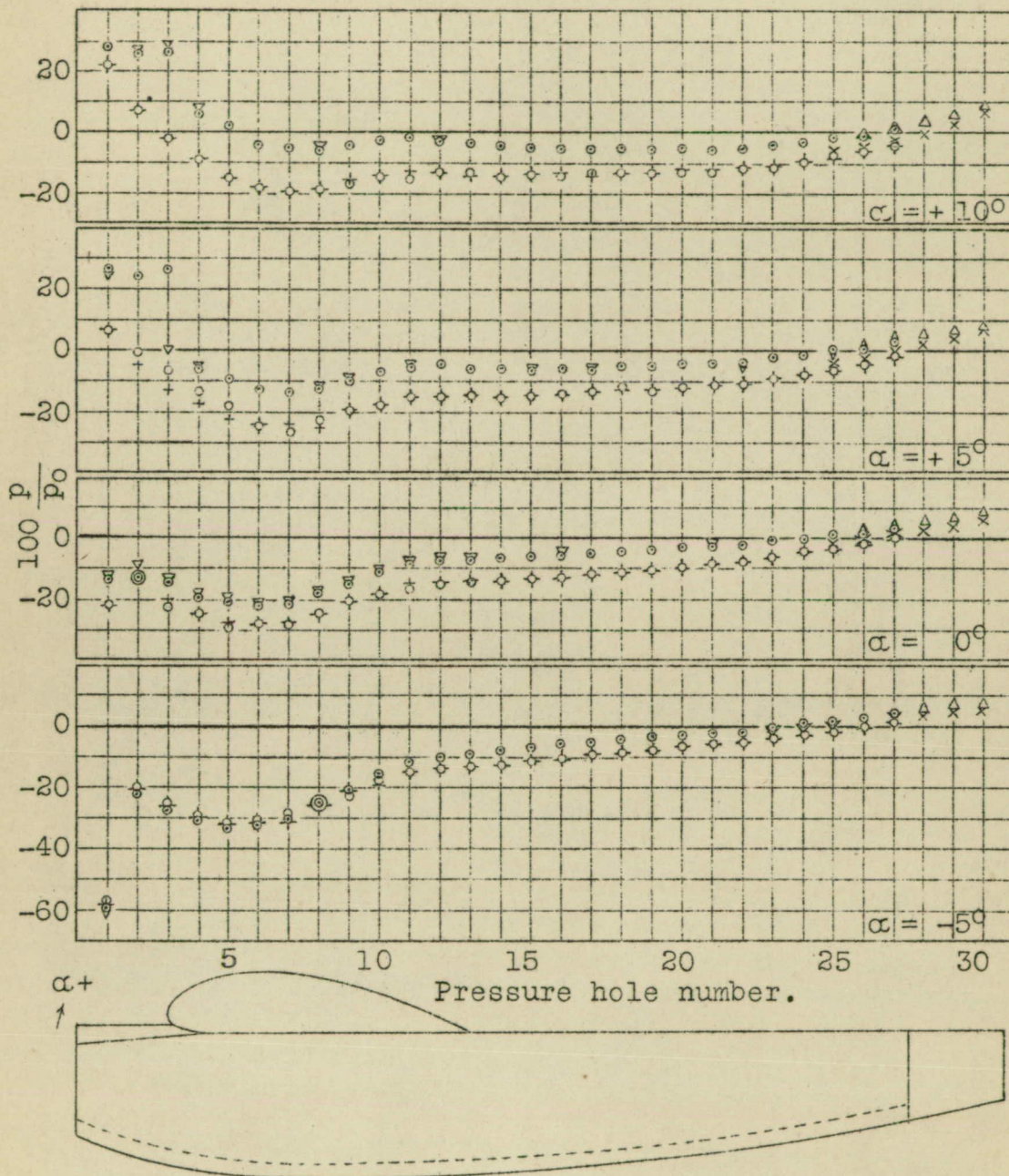⊙ △ ▽ With wing.

Fig.6 Pressure distribution on bottom of fuselage.
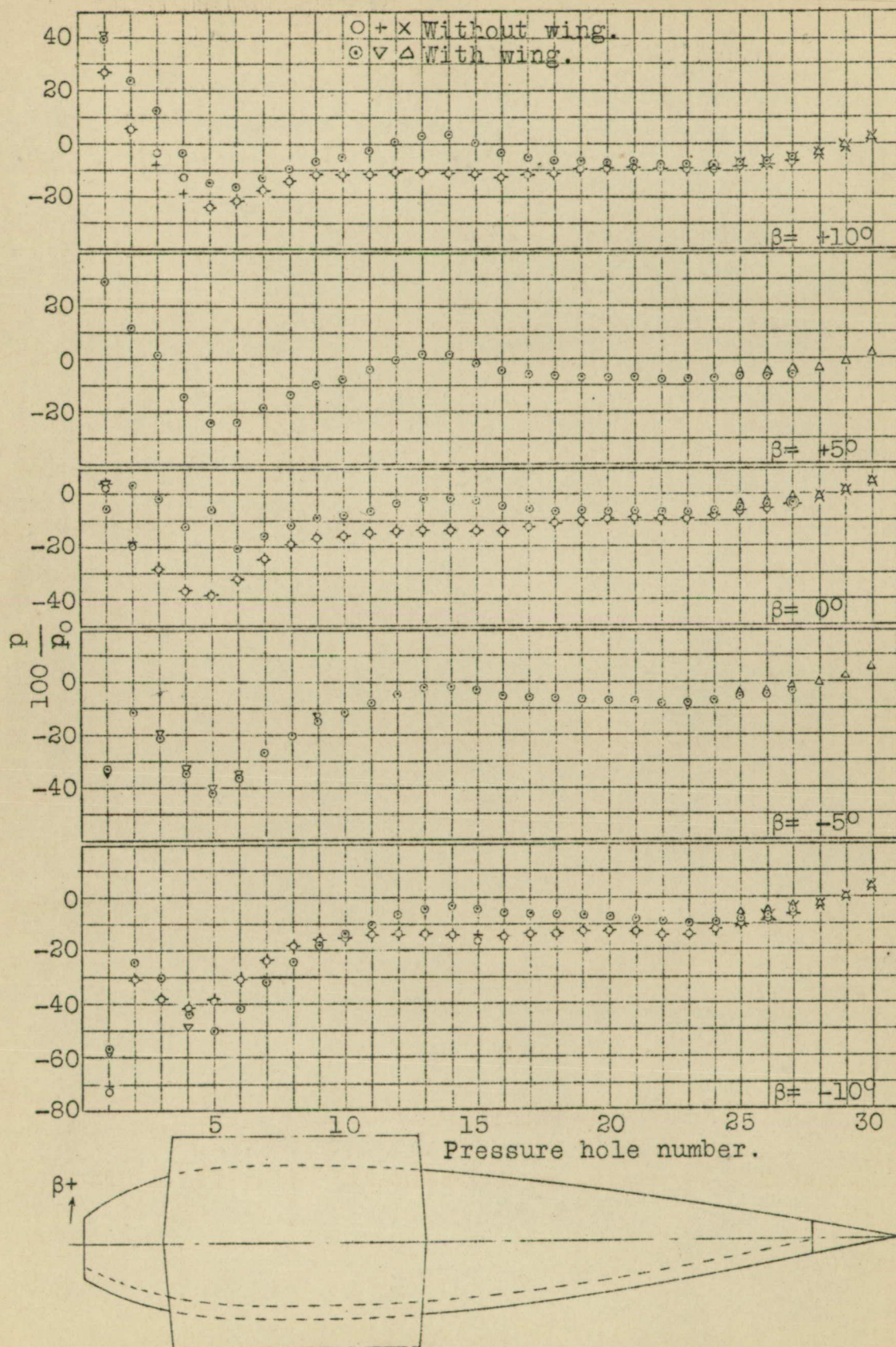
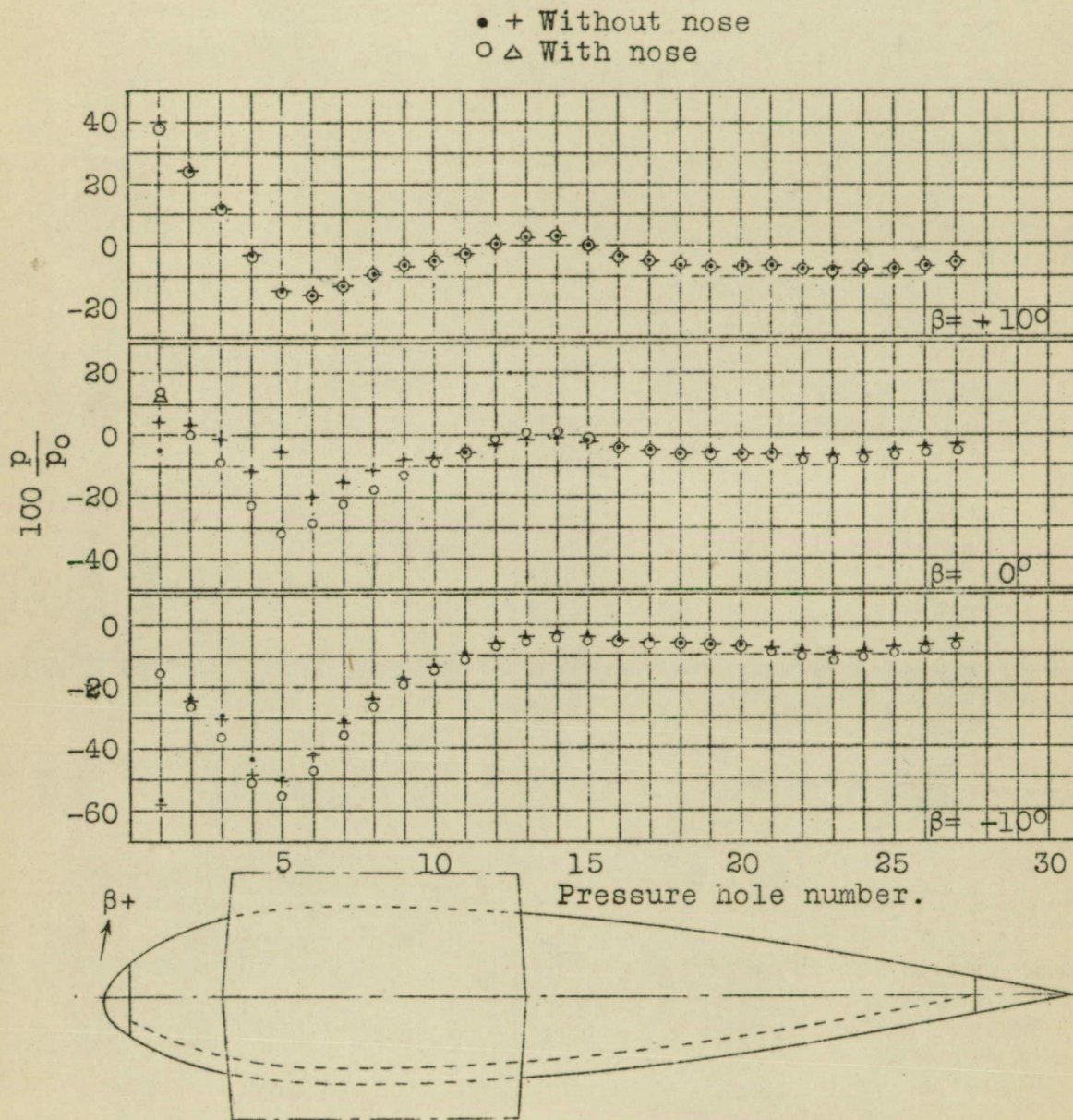Fig.7   Pressure distribution on side of fuselage.

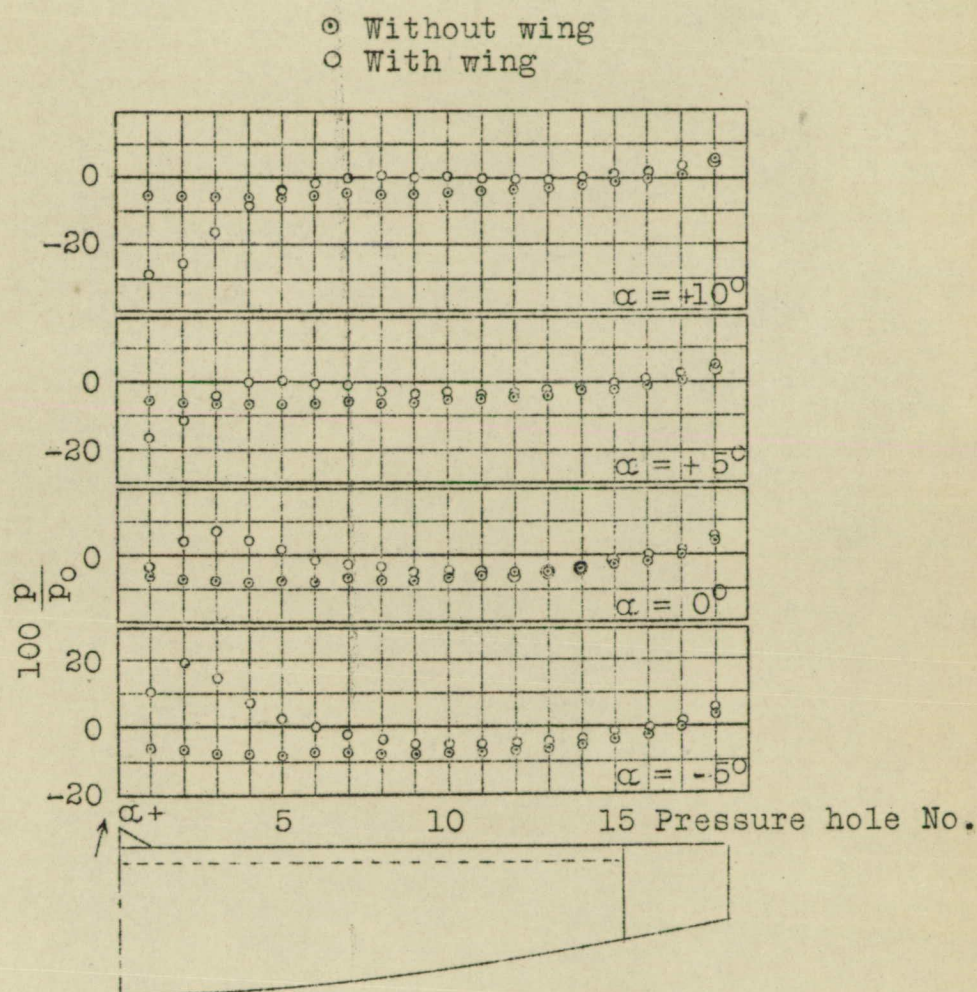Fig.8   Pressure distribution on side of fuselage, with
        and without round nose.

Fig.9 Pressure distribution on top of
       fuselage.